AIBN Master Projects | Dr Amanda W. Kijas

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Get creative, make your own synthetic collagen III

Lead Investigator: Dr Amanda W. Kijas (a.kijas@uq.edu.au)

Collagen is the most abundant protein in our bodies, contributing to the rich diversity of extracellular matrix proteins. The extracellular matrix assists in providing an interconnected network contributing to both the biochemical and biophysical cues to bring about biological responses in cells/tissues. In the initial stages of wound healing collagen III plays a key role in guiding the initial stages of repair. Here we will employ a defined synthetic collagen III to study how this form of collagen assists to guide these early cellular responses of key skin cell types employing 3D live imaging models.

This project will involve growth of various skin cell types, working with 3D culture systems, live confocal imaging, wound healing assays, gene expression, immunostaining and simple chemistry to functionalise biomaterials.

Collagen the founding matrix of our bodies but cellular production is not as simple as we might think.

Lead Investigator: Dr Amanda W. Kijas (a.kijas@uq.edu.au)

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Guiding wound healing through biophysical control

Lead Investigator: Dr Amanda W. Kijas (a.kijas@uq.edu.au)

Wound healing is a dynamic process requiring a coordinated response to repair the damage. The extracellular matrix assists in providing an interconnected network contributing to both the biochemical and biophysical cues to bring about biological responses in cells/tissues. We have defined natural biomaterials to establish 3D cell model systems to study these activities using live confocal microscopy to investigate the role of matrix signalling.

This project will involve growth of various skin cell types, working with 3D culture systems, live confocal imaging, wound healing assays, gene expression and immunostaining.

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Osteocytes the master regulator of bone formation

Lead Investigator: Dr Amanda W. Kijas (a.kijas@uq.edu.au)

The cells of the bone are uniquely isolated from other tissues in our body contained within the hard, impermeable hydroxyapatite matrix. Where osteocytes, the master regulators of bone turnover are the longest living of the bone cells and are individually buried in small hydroxyapatite chambers. Employing a unique live 3D model system this project will investigate how the extracellular matrix properties of osteocytes can alter their signalling to the other bone cells, controlling the constant and ongoing turnover of bone to maintain its integrity and health.

This project will involve osteocyte cell growth and differentiation, working with 3D culture systems, live confocal imaging, gene expression, immunostaining and simple chemistry to functionalise biomaterials.

Bone cell extracellular vesicles, natures ultimate nanoparticles driving cell signalling

Lead Investigator: Dr Amanda W. Kijas (a.kijas@uq.edu.au)

Extracellular vesicles are nature's way of packaging up precious cargo and delivering it to the intended target site to bring about specific biological responses. Bone cells are known to produce a myriad of signalling molecules to communicate with other bone cells and to communicate with distant tissues through systemic delivery. We have identified a novel population of extracellular vesicles that are produced in response to extracellular matrix changes, containing a key signalling molecule. But there is much more to this story and this project will focus on unravelling this further.

This project will involve osteocyte cell growth, working with 3D culture systems, extracellular vesicle characterisation, extracellular vesicle purification, liquid chromatography with tandem mass spectrometry, live confocal imaging, gene expression, western blotting and immunostaining.

Contact the project advisor directly to discuss the project and arrange a meeting or AIBN Events (aibn.events@uq.edu.au) to arrange a visit to the AIBN lab.

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Development of sustainable food packaging from agricultural waste

Dr Nasim Amiralian and Prof Alan E. Rowan

Single-use plastics are the most significant contributor to plastic pollution. In 2016, Australians sent 2.2 million tonnes of plastic to landfill. There is an urgent need for sustainable packaging materials to tackle plastic pollution.

This project aims to develop 100% bio-based and biodegradable single-use packaging materials using sugarcane waste. After extracting sugar from sugarcane, the remaining material known as bagasse is turned into pulp which can be pressed into any desired form. Cane-based materials are biodegradable, compostable, thermally stable, and they are grease and moisture resistant, making them suitable for packaging hot or cold food. However, stronger and lighter materials are needed to make sugarcane packaging an economical alternative to plastic packaging. This project uses cellulose nanofibres derived from sugarcane bagasse to reinforce sugarcane pulp to increase its strength and produce durable, lightweight packaging.

Plant-derived nanofibres have many advantages, such as being natural, abundant, biodegradable, and are exceptionally light and strong. These nanofibres are excellent candidates for use as sustainable materials to reduce the use of petroleum-based plastics in industries such as packaging, automotive, aerospace, and healthcare. For sugarcane packaging, the addition of a small amount of nanofibres to the pulp is expected to significantly improve its mechanical properties as well as increasing the shelf-life of food due to the high oxygen and moisture barrier properties. This material rapidly degrades in both industrial and home compost along with foods, as well as being recyclable, significantly reducing the amount of waste going to landfill. In addition to reducing plastic pollution, this project advances Australia manufacturing by applying nanotechnology and capitalising on organic waste.

Contact the project advisor directly to discuss the project and arrange a meeting or AIBN Events (aibn.events@uq.edu.au) to arrange a visit to the AIBN lab.

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Antiviral materials for the personal protective equipment

Dr Nasim Amiralian and Prof Alan E Rowan

COVID-19 is a novel viral disease, and there is no pre-existing immunity in our community. There is an urgent need to develop simple materials that reduce the risk of infection when handling contaminated products. Every individual should protect themselves from SARS-CoV-2 infection by using personal protective equipment in areas at risk of virus exposure. There are currently no specially developed masks or clothing to protect against viruses. Existing N95 and surgical masks do not completely protect from aerosols in the air and are often in short supply. This project will develop sustainable materials using novel approaches to manufacture antiviral cellulose nanofibres derived from sugar waste industry.

Development of the proposed antiviral materials in collaboration with industry partners will assist the fight against a broader range of viruses and can be applied to a diverse range of surfaces. As a result, the project outcomes will assist with the management of viral pandemics and preparedness for similar events, and in adding value to waste from the sugar industry.

Contact the project advisor directly to discuss the project and arrange a meeting or AIBN Events (aibn.events@uq.edu.au) to arrange a visit to the AIBN lab.

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